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ABSTRACT

The domestic natural gas industry experienced a spectacular growth during the two decades from 1950 to 1970. Demand for gas continues to rise and production has peaked at a time when the price for other energy sources is escalating. A price increase can stimulate production over the short term. Massive LNG imports can help the intermediate term supply. The long term natural gas situation is bleak and substitute natural gas sources must be employed. A conservation program and reordering of priorities for energy sources is essential for the United States as well as most industrial nations.

INTRODUCTION

Mr. Chairman and ladies and gentlemen, on behalf of the PRitchard Company I would like to express our appreciation for the opportunity of participating in this conference.

Total Demand for Natural Gas

In 1953, the marketed production of natural gas increased only 5 percent due to mild weather and the sharpest increase in wellhead price since the Bureau of Mines started collecting such data[1]. That is, from 7.8 cents per thousand cubic feet to 9.2 cents! Production was 8 trillion cubic feet. 1953 also marked the start of a project to liquefy natural gas and transport it from Chicago up the Mississippi River via barge and initiate a new LNG transportation industry.

The same Bureau of Mines reference[1] cites $5.27 per ton f.o.b. for the national average underground coal and $3.75 per ton f.o.b. average for strip-mined coal. The lower cost of natural gas, less expensive combustion equipment, clean environment, convenience, and other factors created a huge demand for natural gas. The expansion of pipelines and aggressive marketing quickly raised the natural gas share of the energy market from 23 percent to the present 39 percent, and a corresponding production of 22 trillion cubic feet.

A difference of opinion existed between the advocates of low prices for the consumers and the actions of a free market on the value of energy. This led to government regulation of interstate transportation of natural gas and a pricing structure not conducive to continued exploration and development of natural gas fields. The net result, regardless of the details, is that the demand for natural gas exceeds the finite supply, and this trend will continue into the future.

A word on the position of Missouri may be appropriate. Small, non-commercial natural gas fields may be found near the Kansas border, especially near Kansas City. Several large natural gas pipelines traverse the state from the South and West to supply the larger population centers. But Missouri must be included near the lowest quartile of states on the basis of all energy sources available. A high ash-sulfur coal is the principal natural energy resource and may be required for conversion to clean fuel gas and liquids. Fortunately, neighbor states have coal, gas or oil in large quantity. The Missouri and Mississippi Rivers provide barge transportation that can move Montana and Dakota coal and lignite seasonally.

The consumption of energy is directly correlated with the economic status of a region. Conservation must be practiced to avoid waste and to use energy in an efficient manner. Curtailment of energy use because our society might run out of energy would be disastrous. The United States with 6 percent of the world population does consume 35 percent of the energy, but it is also the most productive. Our domestic natural gas production has already peaked. Potential gas supply within the main 48 states is estimated as 780 trillions of cubic feet by the Potential Gas Committee[2]. The cumulative production to December 31, 1972, was 432 trillions. The proved reserves are 235 trillions and have shown a steady decline since 1966. Drilling is more expensive per foot, the expected fields are deeper, venture money is more expensive, the time between a discovery and development is now longer, typically eight years, and the magnitude of financial and engineering problems becomes apparent. The easy gas is already in production or near exhaustion. The shortfall of natural gas is now 20 percent and increasing 5 percent per year. Obviously, we are in trouble.

Southern California Edison Company has been effectively stopped by environmental pressures from building or expanding major generation stations. The nuclear facilities and fossil fuel plants alike have met opposition. Desert stations did not fare any better than the coastal sites. Low-sulfur oil from Indonesia replaced most of the domestic oil and coal. The escalation in foreign oil prices has increased the demand for natural gas at a time when natural gas supply is curtailed.

The essence of the natural gas shortage problem can be seen when electricity from natural gas costs one-half that of oil, even before the recent escalation of Fall 1973. Natural gas as fuel created less opposition from environmentalists, the price was also less, and demand soared. Southern California is therefore one of the prime candidates for massive LNG imports.

Public utilities have in principle been able to pass on increased fuel costs to its customers, but the "regulatory lag" between applications and allowed rate increase devours profits in rapid inflation of alternate fuel costs. Electricity must be generated with demand, and natural gas cannot be stockpiled, as was coal, to assure a supply of fuel. LNG is a partial answer to fuel storage, but the cost of LNG storage is prohibitive compared to fuel oil or coal. We, therefore, may see the advent of hybrid systems, with minimum LNG storage for base load natural gas fired plants, and massive low-sulfur oil storage for stockpiled fuel. The use of natural gas for boilers is admittedly an inferior use of clean natural gas, but the price of LNG imported is now competitive with foreign oil and the existing plants must be fueled until alternative generating systems can be operational. The lead time for nuclear power is now longer than LNG imports.

Demands Vs. Allocation

The most visible demand for natural gas is residential. The housewife is a voter and her usage of approximately 24 percent of natural gas consumption carries an immediate vocal impact upon the government regulatory bodies when the utilities are compelled to curtail energy. A slower but ultimately more powerful force will be the influence of an energy curtailment on agriculture. The relation of food production and the energy supply has shown an ever increasing dependence on nitrogen for our high agricultural output[2]. The energy input for corn production, for example, is higher in the form of nitrogen fertilizer than as of gasoline.

Petrochemical feedstock requires energy as gas, oil or coal in the ratio of 14, 82 and 4 percent, respectively. The natural gas portion, however, represents only 2.3 percent of the total natural gas consumption. This is a small but vital segment since existing steam-reforming plants for the production of hydrogen and ammonia cannot switch to coal, the most abundant energy source. Interruptions to fertilizer production have occured this winter so that the reduced supply of ammonia and nitrogen solutions has increased prices. A normal 6 percent rise in demand may be exceeded in view of prospects for good agriculture prices, and a firm domestic and foreign market.

The priorities of end use must take into account the dislocation of the human food chain if natural gas for petrochemical feedstock is not given a high priority. Who is to be denied the gas? In time, the use of natural gas for process heat, electric power generation and commercial space heating may be decreased by alternative energy. The problem seems to be one of longer range planning than allocation of available supply. The incentive to switch is not now an economic one, but should be. Technology is flexible and will present solutions when the economic rules are known sufficiently in advance. Oil or coal can be used as the starting point for substitute natural gas, ammonia, methanol or a range of heavier hydrocarbons. The chemistry is proven; the hardware stage lags because pilot plant and demonstration plant stages lack the risk capital.

Potential Supply

The supply of natural gas in the United States, including the continental shelves and Alaska, requires definition. Cumulative production is based on records of actual production and are accurate to the limits of measurement and data gathering. Proved recoverable reserves include gas in tested geologic formations that can be produced under existing economic conditions and also include gas in undrilled formations that are so related to developed fields nearby that productive ability is assured. The proved reserves at the end of 1972 was 266 trillions of cubic feet. This figure may be compared with 291,287 and 289 in the preceding two year periods. The United States has peaked in 1972 in proved reserves and also in production, which now stands at 22.5 trillions cubic feet per year.

The ratio of proved reserves to current production is 11.8 years and falling. Obviously, natural gas will not be a museum specimen in this century or even into the middle of the next. The hope lies in the potential natural gas discoveries and may be subdivided into probable, possible and speculative. The probable is 266 trillions cubic feet which, by coincidence, is the same as proved reserves. The possible and speculative supply of 384 and 496 trillions cubic feet, respectively, include offshore, deep drilling over 15,000 feet and Alaska. (The collection of these figures by the Potential Gas Committee is published biennially by the Potential Gas Agency of the Colorado School of Mines.)

The aggregate potential supply of 1146 trillions when combined with the proved reserves of 266 trillions gives a comfortable 62.6 years, based on current consumption. But is this realistic? Energy demand growth was 5.6 percent per year during the 1960s. If by some crash exploration and development program, the increased demand for natural gas can be produced without regard to cost, all U.S. potential gas supplies will be exhausted in 1994. In these terms, we have a crisis.

Natural gas imports, domestic production of substitute natural gas and switching of energy demands to other sources of energy is called for. The other energy sources are also in short supply until a coordinated energy plan materializes. Cost is the lever in a free market system. Some lessening of demand will result from increased cost, but the supply is elastic and will respond to the proper price.

Time must also be factored into the options available. Immediate, short, medium and long range mix of actions is required to buy time for the ultimate solution. We cannot propose nor even suggest what that ultimate solution may be, but some phases of actions are presented as examples.

Immediate Federal Power Commission deregulation of wellhead prices for old or vintage gas is necessary in order to provide the capital to put the first phase in operation. This may not be too severe an option since interstate gas sales, or about 40 percent of gas supplies, are state regulated. Opposition by the consuming states should be overcome if a curtailed supply at low price is compared with adequate supply at some increased price. The distribution companies are price regulated, tax-paying utilities, so there will still be some control on consumer prices. Existing gas contracts must be honored or mutually renegotiated. Two or three months should open capped wells, increase wellhead compression capability, and produce gas in excess of present non-profitable gas contracts.

The second supply phase is gas import from Canada and Alaska. The Canadian lead time can be two to three years from Alberta. Alaska and the Mackenzie Delta gas are five to eight years away from initial delivery. When costs are considered, alternate fuels from coal may just as attractive.

The third supply phase is LNG imported from Algeria, Alaska, Iran, Indonesia, Nigeria, South America and The Soviet Union; not necessarily in that order. The reserves are enormous and the only restraint will be balance-of-payments. Algerian LNG imports can significantly increase from the present projects at Arzew and Skikda in less than five years. The Hassi R'Mel and Rhourde Nuss fields exceed 50 trillion cubic feet and can deliver to existing liquefaction sites. The other countries require a longer lead time before massive LNG delivery can bridge the gap to the next phase.

The fourth supply phase must be coal gasification. We have witnessed an attempt to provide SNG from both the light and heavy hydrocarbon liquids. The technology is available, the feedstock is not. Existing plants will continue to operate but new construction is in limbo. Coal is abundant in the United States and can extend the useful life of the huge existing gas distribution network. Other papers in this conference will cover coal gasification technology.

The fate and timing of the gas supply phases is largely a matter of economics, domestic and international. Some gas producing states do not like to be regulated for the benefit of another gas consuming state. The effect of a balance-of-trade deficit due to massive energy imports of oil or gas does not stop at a state line. The four phases must be dovetailed to continue a supply of energy in convenient gaseous form until an ultimate solution emerges.

LNG Technology and Costs

Natural gas occupies about one six-hundredth of its volume when liquefied at atmospheric pressure. Natural gas to be liquefied must be properly treated to remove carbon dioxide and hydrogen sulfide, if present, and water vapor, as well as aromatic and heavy hydrocarbons likely to freeze. Liquefied natural gas offers features highly desirable for peak shaving high demand of limited duration. Large quantities can be economically pumped to any desired delivery pressure, vaporized and added to the existing gas distribution system with complete interchangeability. The only undesirable feature is the potential hazard of a large volume of flammable liquid.

This hazard has long been recognized. Through pioneer work of the Consolidated Natural Gas System, and its subsidiaries, the Hope Natural Gas Company in West Virginia and the East Ohio Gas Company of Cleveland, the first peak shaving plants were constructed. The lack of available cryogenic steels resulted in failure on one LNG storage, without diking, when a disastrous fire destroyed the Cleveland plant in 1944 after four years of operation. Public reaction to the loss of life delayed acceptance of LNG for more than 15 years.

Pritchard was deeply involved with exhaustive fire and storage studies at Lake Charles, Louisiana, in the late 50s and early 60s to prove LNG storage to be safer than LPG or gasoline. The light molecular weight rapidly disperses vapors with no tendency to form explosive pockets at ground level.

The tragic fire at Staten Island, New York, in a novel LNG storage system while undergoing repairs, is generally considered as an isolated accident not likely to be repeated. It should be noted that no danger existed to the area outside of the tank containment. The conventional storage tank design has a heavy inner tank of aluminum or 9 percent nickel steel with an outer vapor-tight carbon steel tank and insulation between the tanks. Earthen or concrete dikes surround the tank. Very large LNG storage tanks also have been constructed of prestressed concrete.

The sea transport of LNG was successfully demonstrated in seven voyages of the Methane Pioneer from Lake Charles, Louisiana, to Canvey Island, England, and the floating pipeline was born. Pritchard and Technip, in a joint engineer-constructor venture for CAMEL, placed the first base load LNG plant in operation at Arzew, Algeria, in 1964. The LNG produced was destined for England and France and thus initiated international trade. Since then the LNG tankers have increased from 27,400 cubic meters to a "standard" of 125,000 cubic meters, about the limit of a single screw ship. Larger twin-screw ships are under study but not presently on firm order.

The various large exporting sources of excess gas reserves are Algeria, the Persian Gulf area, Nigeria, Indonesia, Alaska, Australia and the world's largest reserves of the U.S.S.R. Importing energy-short nations are Japan, France, England, Italy and the United States. The shortages will grow and competition for this energy will increase in pace with the demand for crude oil and its products. The financing of these projects present major challenges. For example, a plant in the Persian Gulf to export one billion cubic feet per day to the United States, either east, west or gulf coasts, costs about 450 million dollars; the wells and pipeline another 250 million, the 18 LNG transports at over 100 million each and receiving terminals at close to 100 million each - 2.5 billion total. (Same SNG from coal; 1.6 billion including mining.) But this size of plant must be duplicated many (30) times to alleviate the projected short fall of 30 billion cubic feet per day of unsatisfied demand by 1980, the target date of Project Independence. Obviously, the demand cannot be allowed to climb as projected.

The industry faces manpower shortages for engineers, designers and construction specialists as well as material for a large LNG import program. The projects will develop only as fast as the men, material and finances become available.

Current News

Before presenting the conclusions, it is appropriate to mention three news items which nicely illustrate some of the forces at work:

1. A major gas distribution company announces the suspension of construction of a big plant to make SNG from petroleum because suppliers cannot deliver feed stocks in accordance with contracts already ratified.

2. The office of coal research awards a feasibility study of various processes to convert coal to SNG. The estimated completion time for study is two years.

3. Fourteen major oil and gas companies, which have been studying the methanation step in the manufacture of SNG from coal on a commercial scale in Scotland, will now support development on a commercial scale of a process invented by the British Gas Corporation for the gasification of coal. This process was invented more than ten years ago, but has never been taken beyond the pilot plant stage.

Conclusions

The energy shortage is here to stay and LNG imports can furnish but a small portion of the projected shortfall. Natural gas is a vital segment of the energy spectrum and the effort must be made to: (i) reduce demand; (ii) increase domestic production for the immediate demand; (iii) establish a system of priority energy use, preferably based on a free market with a minimum of political regulation; (iv) develop an alternate supply of substitute natural gas from coal; (v) expand LNG peak shaving plants to avoid distribution bottlenecks; (vi) increase import of natural gas from Alaska and Canada; (vii) aggressively develop import LNG programs; and (viii) develop the long range solutions such as nuclear energy.

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